

Adolescent problem behaviours predicting DSM-IV diagnoses of multiple substance use disorder: Findings of a prospective birth cohort study

Mohammad Reza Hayatbakhsh^{1,2}, Jake Moses Najman^{1,3}, Konrad Jamrozik¹, Abdullah Al Mamun¹, William Bor⁴ and Rosa Alati¹

(1) QADREC, School of Population Health, The University of Queensland, Herston Road, Herston, QLD, 4006, Australia

(2) Qom University of Medical Science, Qom, Iran

(3) School of Social Science, University of Queensland, Brisbane, QLD, Australia

(4) Mater Centre for Service Research in Mental Health, Mater Hospital, Brisbane, QLD, Australia

ABSTRACT

Background: Whether there is an independent association between problem behaviours and substance use disorders (SUD) needs further investigation. This study examined prospective associations of adolescent psychopathology and problem behaviours with SUD in early adulthood, and whether these associations are confounded by other factors.

Method: Data were from a prospective study of 2,429 young Australian adults from birth to the age of 21 when data on SUD were collected. Adolescent psychopathology and behaviour were assessed at 14 years via the Youth Self Report instrument on eight sub-scales of emotional and behavioural problems.

Results: In multivariate analyses, attention problems, delinquency, and aggression were associated with both single and multiple SUD in early adulthood, with delinquent behaviour being the strongest predictor (OR = 2.0, 95% CI 1.4–2.9 for one SUD and OR = 3.6, 95% CI 2.4–5.0 for multiple SUDs).

Conclusions: Problem behaviours, in particular delinquency and aggression in early adolescence predict long-term SUD. The results suggest that substance use prevention programs should target adolescents with early symptoms of psychopathology and problem behaviour.

Key words: adolescent - problem behaviours - young adult - substance use disorder

INTRODUCTION

There is extensive evidence suggesting that mental health status and problem behaviours are associated with early substance use problems. These include externalizing behaviours such as conduct problems, aggression, delinquency, and attention deficit hyperactivity disorder (ADHD), as well as internalizing behaviours such as anxiety and depressive symptoms [3, 5, 9, 10, 12, 13, 16, 18, 21–23, 27, 30, 32]. However, there is a paucity of information about the relationship between other problem behaviours (such as somatic problems and thought problems) and substance use in early adulthood [12]. Problem behaviours such as attention difficulties and conduct problems often co-occur [8], and there is also evidence of co-occurrence of internalizing and externalizing behaviours [14]. This makes it difficult to assess the independent contribution of individual problem behaviours to later development of substance use.

To date, no study has investigated the association between a broad range of problem behaviours and substance use disorder (SUD) and multiple SUDs. Existing studies [12, 31] have lacked statistical power to measure the use of illicit drugs other than cannabis separately. Some other studies have failed to control for a range of potential confounding factors [16]. These weaknesses limit our ability to understand the nature

and direction of the association between psychopathology and SUD. The present paper examines the relationship between symptoms of problem behaviour in early adolescence and SUD and multiple SUDs in early adulthood. As both problem behaviours and SUD may be predicted by the same set of underlying factors, such as socioeconomic status (SES), family problems, maternal mental health, and maternal substance use [4, 5, 15, 30], we also examine whether any primary association can be explained by these life course confounders. The problem behaviours examined in this paper are those related to social withdrawal, somatic symptoms, anxiety/depression, social interactions, thinking, attention, delinquency, and aggression assessed when the child was 14 years old. We defined SUD in terms of abuse or dependence related to nicotine, alcohol, cannabis, and other illicit drugs, as measured in early adulthood.

METHODS

Sample

We used data from the Mater Hospital and University of Queensland Study of Pregnancy and its outcomes (MUSP) [26], a birth cohort study of women enrolled in Brisbane, Australia, between 1981 and 1983. Baseline data were collected at the first antenatal visit from 7,223 consecutive women who gave birth to live singleton babies and were followed up at 3–5 days, 6 months, and 5, 14, and 21 years after the birth. At 14 and 21 years both mothers and children were interviewed. Written informed consent was obtained from the mother at all phases of data collection and from the young adults at the 21-year follow-up of the study. Ethics committees at the Mater Hospital and the University of Queensland approved each phase of the study. Due to financial constraints at the 21-year follow-up, a computerized version of the Composite International Diagnostic Interview (CIDI-Auto) [33] was administered to a sub-cohort of 2,546 young adults. This study is based on 2,429 young adults (51.2% female and 48.8% male) who completed the CIDI-Auto at the 21-year follow-up and for whom data were available on problem behaviours at the 14-year follow-up.

Measures

Young adults' substance use disorders

At the 21-year follow-up, those who reported using a drug at least “five times ever” completed the corresponding drug use section of the self-administered CIDI-Auto to assess the presence of life-time drug-related abuse or dependence (disorders) as defined by DSM-IV criteria. The substances included in the study were nicotine, alcohol, cannabis, amphetamines, ecstasy, heroin, cocaine, hallucinogens, inhalants, and other drugs. Based on individuals' responses at 21 years, they were divided into three categories: no SUD, one SUD, and multiple (two or more) SUDs.

Adolescent problem behaviours

At the 14-year follow-up, problem behaviours were assessed using the eight syndrome subscales of the Youth Self Report (YSR) [2]. The YSR has the same format as the Child Behaviour Checklist (CBCL) [1], except that YSR items are worded in the first person. The problem items are scored 0 if the behaviour is not “true”, 1 if the behaviour is “sometimes or somewhat true”, and 2 if the behaviour is “very true or often true”. The eight subscales constructed by Achenbach include social withdrawal, somatic complaints, anxiety/depression, social problems, thought problems, attention problems, delinquency, and aggression. The use of the CBCL and YSR and their good validities and internal consistencies have been described

elsewhere [29]. In the present cohort, the eight subscales had good internal consistency (Cronbach's alpha between 0.68 for somatic problems and 0.90 for aggressive behaviour). To predict individuals' risk of substance use on the basis of their problem behaviours, congruent with other studies [16], the 90th percentile of the cumulative frequency distributions of the YSR was used as the cut-off point above which subjects were regarded as "cases".

Potential confounders

The association between adolescent problem behaviours and SUD might be confounded by other covariates. These include SES, family structure and quality of parents' marital relationship, parental mental health, the parent–child relationship, and parental substance use. Maternal SES was obtained at baseline along with maternal age and highest level of education. Maternal marital status was self-reported by mothers at the 14-year follow-up as being un-partnered or living with the child's biological (intact family) or step-father (non-intact family). The quality of maternal marital relationships at 14 years was assessed using a short form of the dyadic adjustment scale (DAS) [28].

We used the delusions-symptoms-states inventory (DSSI) [7] to assess maternal anxiety and depression at the 14-year follow-up. The DSSI contains two 7-item subscales measuring depression and anxiety that have been found to correlate strongly with other scales of depression including the Beck Depression Inventory [25].

The Parent-Adolescent Communication Scale [6] was used to assess mother–child communication at the 14-year follow-up. This instrument has two sub-scales addressing openness in family communication and problems with family communication. For the purpose of this study, the ten-item problem sub-scale (administered to the mothers) was used as the measure of mother–child communication (Cronbach's alpha = 0.78).

Maternal alcohol and tobacco consumption were also assessed at the 14-year follow-up. We obtained information on frequency (from never to daily) and quantity (from 0 to 7+ glasses) of alcohol consumption. Mothers also recalled how many cigarettes they had smoked over the 7 days prior to survey.

Analysis

We computed Pearson's correlation coefficients (r) to estimate the correlation between adolescent scores on the eight sub-scales of the YSR, and explored univariate associations between YSR sub-scale scores and SUD using chi-square tests and unadjusted logistic regression. We then fitted multivariate logistic regression models for each SUD with the eight sub-scales of the YSR as the independent variables. Using two additional multivariate regressions, we first adjusted for all YSR sub-scales scores and then included a range of covariates that could confound the association between YSR sub-scale scores and SUD. These factors were the child's gender, maternal SES, maternal marital status and quality, maternal mental health, and maternal alcohol and tobacco use at the 14-year follow-up. Due to missing data on some of covariates measured between the child's birth and age 14 years, this multivariate analysis was conducted on 2,384 participants for whom complete data were available.

In a series of sensitivity analyses we assessed whether our results reflected the specific follow-up phase at which the various variables were assessed. One could argue that measuring confounding factors and

independent variables concurrently may raise issues of temporal sequence. In order to address this, we included maternal marital status and quality, maternal anxiety and depression, and maternal tobacco and alcohol consumption at 5 years as the possible confounding factors. Moreover, we repeated the entire analysis using maternal reports of adolescent problem behaviours (CBCL). We also conducted a complementary analysis for the associations between problem behaviours at 14 years and life-time diagnosis of substance dependence, as opposed to SUD, measured at 21 years. The results of these sensitivity analyses did not differ substantively from those presented here.

Finally, we computed probability weights using a logistic regression model, with the outcome being complete data or not, to account for those of the 7,223 original cohort members for whom we did not have complete follow-up data to 21 years. These individuals were more likely to be male, and to have been born to mothers who were less educated, more likely to be single, to smoke and to be anxious and depressed at baseline. We incorporated the weights based on the inverse probability of having missing outcome data [17] into our principal analyses to examine the impact on our key findings.

The results of all unadjusted and adjusted models are presented as odds ratios (ORs) together with 95% confidence intervals (CIs) as the indicator of statistical significance. All analyses were carried out using SPSS V.13 and STATA V.9.

RESULTS

Characteristics of the sample

Overall, 2,429 young adults had complete data on the CIDI-Auto for abuse and dependence related to nicotine, alcohol, cannabis, and other illicit drugs in early adulthood, as well as full information on problem behaviours at the 14-year follow-up. The average ages of participating children were 13.90 years ($SD = 0.33$) at the 14-year assessment, and 20.45 years ($SD = 0.84$) at the 21-year follow-up. At baseline (1981–1983), 19.9% of mothers reported having had tertiary education, 64.1% had completed high school and 16.0% had not finished high school education.

Some 57.5% of young adults had no evidence of ever having had a SUD, 21.8% (25.0% males and 18.7% females) met the criteria for life-time diagnosis of one SUD, and 20.7% (27.1% males and 14.6% females) met the criteria for life-time diagnosis of two or more SUDs. Alcohol abuse or dependence were the most common SUDs, with 27.6% of individuals (38.4% males and 17.4% females) having ever had symptoms of alcohol disorders (AD); cannabis use disorder (CD) was reported by 21.7% (29.6% males and 14.2% females) of the sample, nicotine disorder (ND) by 15.9% (15.9% males and 16.0% females), and other illicit drugs disorder (OID) by 9.2% (10.8% males and 7.7% females). There were significant correlations between the eight subscales of YSR ($P < 0.001$) (Table 1). The strongest associations were observed between anxiety/depression and symptoms of social withdrawal ($r = 0.66$), attention problems and aggressive behaviour ($r = 0.62$), and between delinquency and aggression ($r = 0.59$).

Table 1: Correlations (*r*) between YSR problem behaviours at 14 years (*n* = 2,429)

Behaviours	Somatic	Anx/Depress	Social	Thought	Attention	Delinquency	Aggression
Withdrawal	0.45	0.66	0.54	0.47	0.42	0.23	0.30
Somatic	–	0.53	0.32	0.47	0.42	0.28	0.38
Anx/Depress		–	0.52	0.59	0.56	0.29	0.48
Social			–	0.45	0.56	0.23	0.40
Thought				–	0.56	0.36	0.53
Attention					–	0.46	0.62
Delinquency						–	0.59
Aggression							–

Pearson's correlation coefficients (*r*) are significant at the $P < 0.0001$

YSR youth self report

Unadjusted and adjusted associations between problem behaviours and SUD

Table 2 shows the proportions of young adults' life-time diagnoses of ND, AD, CD, and OID for each problem behaviour measured at 14 years. Adolescents with extreme withdrawal, somatic or social problems showed greater proportions of ND by early adulthood, but not other SUDs. Symptoms of anxiety/depression and thought problems at 14 years were related to modest but significant increased likelihood of developing ND or OID. All types of SUD were over-represented in adolescents with attention, delinquency, or aggression problems.

Table 2: Percent with substance use disorders by early adulthood for each YSR problem behaviour at 14 years (*n* = 2,429)

Behaviours at 14 years		<i>n</i>	Young adults' substance use disorders (%) ^a			
			Nicotine	Alcohol	Cannabis	Others
Withdrawal	Normal	2,173	15.0	18.0	22.0	9.0
	Top 10%	256	23.0 [†]	26.0	22.0	10.0
Somatic	Normal	2,195	15.0	27.0	21.0	9.0
	Top 10%	234	28.0 [†]	32.0	27.0	12.0
Anxiety/depression	Normal	2,194	15.0	28.0	22.0	9.0
	Top 10%	235	26.0 [†]	25.0	21.0	14.0 [†]
Social	Normal	2,225	15.0	28.0	22.0	9.0
	Top 10%	204	23.0 [†]	26.0	22.0	10.0
Thought	Normal	2,199	15.0	27.0	21.0	9.0
	Top 10%	230	27.0 [†]	32.0	29.0 [†]	15.0 [†]

Attention	Normal	2,220	15.0	27.0	20.0	9.0
	Top 10%	209	31.0 [†]	38.0 [†]	36.0 [†]	14.0 [†]
Delinquency	Normal	2,159	14.0	25.0	19.0	8.0
	Top 10%	270	33.0 [†]	49.0 [†]	43.0 [†]	22.0 [†]
Aggression	Normal	2,190	15.0	26.0	20.0	8.0
	Top 10%	239	27.0 [†]	39.0 [†]	39.0 [†]	19.0 [†]

[†]Proportion with substance use disorder for each category; *P* value from chi-square: [†]<0.01, [‡]<0.05

Table 3 presents risk of young adults' SUDs for eight subscales of YSR problem behaviour. There was a modest relationship linking symptoms of withdrawal, social and somatic problems to ND, but not to other SUDs. YSR anxiety/depression at 14 years predicted ND and OID, but not AD and CD. Children who met the criteria for thought problems at 14 years were more likely to report symptoms of life-time ND, CD, OID, but not AD at 21 years. Further, univariate analyses showed a substantial increase in all of ND, AD, CD, and OID among young adults who had had symptoms of attention problems, aggression and especially delinquency at 14 years.

Table 3 Associations between YSR problem behaviours at 14 years and young adults' substance use disorders (*n* = 2,429)

Behaviours at 14 years	Young adults' substance use disorders odds ratio (95% confidence interval)							
	Nicotine		Alcohol		Cannabis		Others	
	Unadjusted	Adjusted ^a	Unadjusted	Adjusted ^a	Unadjusted	Adjusted ^a	Unadjusted	Adjusted ^a
Withdrawal	1.6 (1.2, 2.2)	1.0 (0.7, 1.4)	0.9 (0.7–1.2)	0.8 (0.6, 1.1)	1.0 (0.7–1.4)	0.8 (0.5, 1.1)	1.1 (0.7–1.7)	0.7 (0.4, 1.2)
Somatic	2.3 (1.7, 3.1)	1.6 (1.1, 2.3)	1.2 (0.9–1.7)	1.2 (0.8, 1.6)	1.3 (1.0–1.8)	1.1 (0.8, 1.6)	1.5 (1.0–2.2)	1.1 (0.7, 1.7)
Anxiety/Depression	2.0 (1.5, 2.8)	1.2 (0.8, 1.7)	0.9 (0.6–1.2)	0.6 (0.4, 0.9)	1.0 (0.7–1.4)	0.6 (0.4, 0.9)	1.7 (1.1–2.5)	1.2 (0.7, 2.0)
Social	1.7 (1.2, 2.3)	1.1 (0.7, 1.6)	0.9 (0.7–1.3)	0.8 (0.5, 1.1)	1.0 (0.7–1.4)	0.7 (0.5, 1.1)	1.1 (0.7–1.7)	0.8 (0.4, 1.3)
Thought	2.1 (1.5, 2.8)	1.1 (0.7, 1.6)	1.2 (0.9–1.7)	1.0 (0.7, 1.4)	1.6 (1.2–2.1)	1.1 (0.7, 1.6)	1.8 (1.2–2.7)	1.2 (0.7, 2.0)
Attention	2.6 (1.9, 3.6)	1.5 (1.0, 2.2)	1.7 (1.3–2.3)	1.5 (1.0, 2.1)	2.2 (1.7–3.0)	1.7 (1.2, 2.6)	1.8 (1.2–2.7)	0.9 (0.5, 1.5)
Delinquency	3.2 (2.4, 4.2)	2.5 (1.8, 3.4)	2.8 (2.2–3.7)	2.6 (2.0, 3.5)	3.1 (2.4–4.1)	2.5 (1.9, 3.4)	3.5 (2.5–4.9)	2.9 (2.0, 4.2)
Aggression	2.2 (1.6, 3.0)	1.1 (0.7, 1.6)	1.8 (1.4–2.4)	1.3 (0.9, 1.8)	2.6 (2.0–3.5)	1.9 (1.3, 2.6)	2.7 (1.9–3.8)	1.7 (1.1, 2.7)

^aAdjusted for other behaviours in the table

To examine the independent association between each subscale of problem behaviour and young adults' SUD, we fitted a multivariate regression model for each SUD including all problem behaviours. Table 3 shows that after such adjustment there was no significant association of withdrawal, social, and thought problems with any SUD measured at 21 years. Children with somatic problems at 14 years were more likely to report life-time ND at 21 years, and individuals with more symptoms of anxiety/depression were less likely to be diagnosed with AD and CD, but anxiety/depression was not associated with the other SUDs. There was attenuation in the associations between each SUD and attention problems but they remained significant for ND, AD and CD after we controlled for the other behaviours. Children who manifested symptoms of delinquency were at least two and a half times more likely to develop each of the SUDs by 21 years. Multivariate regression led to non-significant associations between aggressive behaviour and ND and AD, and attenuated the relationship for CD and OID. In summary, the data in Table 3 indicate that attention

problems, delinquency, and aggression predict SUDs even when the other behaviours are taken into account.

Of the eight subscales of the YSR, five were significantly associated with at least one SUD in our multivariate regression models. Univariate and multivariate relationships between these behaviours and young adults' single and multiple SUDs are presented in Table 4. In unadjusted analyses, somatic, attention, delinquent, and aggressive problem behaviours predicted both single and multiple SUDs reported at 21 years. These associations were somewhat attenuated when controlled for each other, but did not materially alter when further controlled for a large group of potential confounding factors. Multivariate analyses indicated that an adolescent's self-report of delinquent behaviour is the strongest predictor for SUD, with the stronger relationship being for multiple SUD (OR = 3.6; 95% CI: 2.5, 5.1). Further, attention problems and aggressive behaviour at 14 also predicted SUD in young adults, independent of other problem behaviours and potential confounders.

Table 4: YSR problem behaviours at 14 years predicting young adults' multiple substance use disorders (*n* = 2,384)

Problem behaviours	Young adults' substance use disorders ^a											
	Unadjusted				Adjusted for all behaviours				Fully adjusted model ^b			
	1 SUD		Multiple SUD		1 SUD		Multiple SUD		1 SUD		Multiple SUD	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Somatic	1.6	1.1, 2.2	1.7	1.2, 2.3	1.4	1.0, 2.1	1.3	0.9, 1.9	1.5	1.0, 2.3	1.5	1.0, 2.2
Anxiety/Depression	1.1	0.8, 1.5	1.3	0.9, 1.9	0.7	0.5, 1.1	0.8	0.5, 1.2	0.7	0.5, 1.1	0.9	0.5, 1.3
Attention	2.1	1.4, 2.9	2.7	1.9, 3.8	1.6	1.0, 2.4	1.7	1.1, 2.6	1.6	1.0, 2.4	1.8	1.2, 2.8
Delinquency	2.9	2.0, 4.0	5.3	3.9, 7.3	2.2	1.5, 3.2	4.2	3.0, 5.8	2.0	1.4, 2.9	3.5	2.4, 5.0
Aggression	2.4	1.7, 3.3	3.2	2.3, 4.4	1.7	1.2, 2.6	1.8	1.2, 2.6	1.7	1.1, 2.5	1.6	1.1, 2.4

^aNo substance use disorder as reference category

^bAdjusted for all problem behaviours plus gender, mother's age and mother's education when the child was born, maternal marital status and quality, maternal anxiety and depression, mother–child communication, and maternal smoking and alcohol use at 14 years; SUD: substance use disorder

Sensitivity analyses

In a complementary analysis, we substituted maternal reports (CBCL) of adolescent problem behaviours for self-reports (YSR) and repeated all analyses. The new findings showed similar patterns to those presented here (see Table 5 for comparison). As the delinquent behaviour subscale of the YSR includes an item about using drugs and/or alcohol, this might cloud the interpretation of adolescent delinquent behaviour as a predictor of later SUDs since the apparent association could reflect continuity of substance use over time. Hence, we deleted the item and repeated the analyses here. Again, the new analyses showed no material change compared with the present results [fully adjusted results for one SUD (OR = 1.9, 95% CI 1.3–2.8), for multiple SUD (OR = 2.9, 95% CI 2.0–4.2)].

Table 5 CBCL problem behaviours at 14 years predicting young adults' multiple substance use disorders (*n* = 2,386)

Problem behaviours	Young adults' substance use disorders ^a											
	Unadjusted				Adjusted for all behaviours				Fully adjusted model ^b			
	1 SUD		Multiple SUD		1 SUD		Multiple SUD		1 SUD		Multiple SUD	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Somatic	1.0	0.7, 1.5	1.1	0.7, 1.6	0.9	0.6, 1.4	0.9	0.6, 1.3	1.0	0.7, 1.5	1.0	0.6, 1.5
Anxiety/depression	1.0	0.7, 1.4	1.2	0.8, 1.7	0.7	0.4, 1.0	0.6	0.4, 1.0	0.7	0.5, 1.1	0.7	0.4, 1.1
Attention	1.5	1.1, 2.0	1.9	1.3, 2.7	1.2	0.8, 1.9	1.1	0.7, 1.8	1.0	0.6, 1.6	0.9	0.6, 1.3
Delinquency	2.5	1.8, 3.5	4.2	3.0, 5.8	2.4	1.6, 3.6	3.6	2.4, 5.2	2.0	1.3, 3.0	2.6	1.8, 3.9

^aNo substance use disorder as reference category^bAdjusted for all problem behaviours plus gender, mother's age and mother's education when the child was born, maternal marital status and quality, maternal anxiety and depression, mother–child communication, and maternal smoking and alcohol use at 14 years; SUD: substance use disorder

We also used maternal marital status and quality, maternal anxiety and depression, and maternal tobacco and alcohol consumption at 5 years (instead of 14 years) as possible confounders for the associations between problem behaviours and SUD. Furthermore, we examined the associations between problem behaviours at 14 years and life-time diagnoses of substance dependence, rather than disorder, measured at 21 years. The results of these sensitivity analyses also did not differ substantially from those presented here, although the point estimate of association were slightly attenuated. For example, adolescent with extreme level of delinquent behaviour had OR = 1.9 (95% CI 1.4–2.8) and OR = 2.7 (95% CI 1.8–4.0) for development of one and multiple SUDs, respectively. Finally, we found no important differences between the weighted and non-weighted results when the analyses included inverse probability weights for non-participating subjects, which suggests that attrition is unlikely to have introduced major biases into our findings in either direction.

DISCUSSION

Main findings

We investigated associations between a broad range of behavioural and emotional problems assessed in adolescence and life-time diagnoses SUD in young adults in a large Australian birth cohort. Our findings indicate that attention problems, delinquency and aggression predict later ND, AD, CD, and OID as well as multiple SUDs, independently of each other and of five other categories of emotional and behavioural problems. The strongest relationships were found for adolescent delinquent behaviour; the initially significant associations with withdrawal symptoms, somatic, social, and thought problems disappeared after we controlled for other problem behaviours. By contrast, symptoms of anxiety/depression in adolescence were associated with lower AD and CD when other behaviours were taken into account. These results extend findings from prior population studies on the link between problem behaviours and substance use. Our study makes an important contribution to the evidence for several reasons: it has used data from a large birth cohort study and therefore generated relatively precise estimates of effects; it has examined,

simultaneously, a wide range of problem behaviours in early adolescence and taken the others into account as the association with each one is explored; it has tested the validity of self-reported YSR against maternal-report CBCL; and it has controlled the associations between problem behaviours and SUD for a wide range of potential confounding variables.

Within the MUSP cohort, univariate and multivariate analyses of the association between anxiety/depression and SUD yielded contrasting results. In unadjusted analyses, symptoms of anxiety and depression in adolescence predicted later disorders related to nicotine and other illicit drugs but none of the associations was significant in our fully adjusted models. This finding supports previous investigations indicating that anxiety and depression in adolescence are not associated with later substance use problems [5, 12, 13, 22], but disagree with some other studies [18, 21, 31, 32]. Among the reasons that might explain this discrepancy are differences in instruments measuring symptoms of anxiety and depression and/or substance use, and in the level of control for concurrent psychopathology and other confounding factors [18, 21, 31, 32]. Moreover, the affirmative studies that suggested a weak predictive value for anxiety and depression are mainly based upon longitudinal data with a follow-up shorter than in our study. It seems plausible that short-term association might diminish in the longer term. In the present investigation, symptoms of anxiety/depression were negatively associated with AD and CD once the scores on the other YSR sub-scales were taken into account. Notwithstanding, further investigations that use alternative measures of anxiety/depression and run in long-term follow-up are required to examine the robustness of our finding.

Consistent with previous investigations [8, 9, 11, 19, 21], our study confirms that conduct (delinquent behaviour) disorder has been most strongly associated with substance use and abuse, and points to a significant independent role for delinquency in the prediction of SUDs [13, 22, 27, 30]. Further, our data indicate that attention problems are associated with increased single and multiple SUDs, even when scores on other YSR sub-scales with significant predictive value in univariate analyses were entered into the same statistical model. In contrast with Ferdinand et al. [12], in the present investigation a significant univariate relationship between YSR thought problems and SUD did not persist after adjustment for other behaviours. This inconsistency might be due to differences in measurement of substance use, as Ferdinand and colleagues based their analyses on self-reports of substance use rather than DSM criteria of substance abuse or dependence.

Possible explanations for the associations

There are several possible explanations for the associations between some problem behaviours and SUDs. The first is that both problem behaviours and SUD are separate manifestations of common causal factors [4], either genetic or environmental, or some combination of them. Although we cannot test for genetic influences, our multivariate model accounted for a range of possible environmental factors and showed that the magnitude of the apparent associations was not attenuated after controlling for confounders. However both delinquent behaviour and substance use (licit and illicit) may reflect a lower level of attachment to the dominant social values of the society. Both delinquent behaviour and substance use can be conceptualized as rule breaking behaviour—and it may be that such rule breaking is increasing.

A second possible explanation involves the self-medication hypothesis which proposes that individuals with problem behaviours may take substances to relieve their symptoms [20]. If this was the case, we would

expect to see a positive association for most, if not all problem behaviours. The fact that we only found a positive association with some problem behaviours but not others makes self-medication less likely to be on the causal pathway leading to SUD in young adults.

Finally, adolescents with problem behaviours are more likely to drop out of school, lose their social bonds, achieve a lower level of education, and face difficulties in finding appropriate jobs [24]. These social consequences may make adolescents and young adults susceptible to affiliation with deviant groups and may lead to the use of substances. We cannot test this pathway, since the MUSP study has very limited information on peer influences in adolescence.

Strengths and limitations of the study

To our knowledge this is the first study with a birth cohort design examining the relationship between a broad range of emotional and behavioural problems and DSM-IV measures of single and multiple SUD. Our study also adds to the existing evidence through our ability to take into account a range of life-time factors which could explain associations between behaviours in adolescence and later substance use. Specifically, we adjusted for maternal depression and anxiety, and maternal tobacco and alcohol use, which have all been found to be associated with children's problem behaviours and substance abuse disorders.

The main limitation of our study is loss to follow-up. The present analyses were conducted on data from a sub-sample of the initial birth cohort who completed the CIDI at the 21-year follow-up. This group represents 35.2% of the 7,223 original participants and such loss theoretically may introduce bias into our results. The characteristics of participants lost from the study suggest that we may be under-estimating both the prevalence of SUDs and the strength of the associations we found. However, the additional analysis using inverse probability weighting suggests that attrition is unlikely to have introduced substantial bias into our findings in either direction. On the other hand, the long period between the 14- and 21-year follow-ups of the MUSP did not allow us to examine hypothetical links along the pathway between problem behaviours and SUDs.

Implications

Within the context of these limitations, if one accepts that delinquency is the main predictor of SUDs, this has significant implications for the prevention and treatment of substance use and SUDs. It can be expected that effective intervention for problem behaviours may reduce substance use in adolescents and young adults. Further investigations may help clarify the pathways from problem behaviours to SUD. Early detection of adolescent problem behaviours and further research on effective intervention models for these groups could help reduce SUD and multiple SUDs, in particular, and their negative consequences in adolescence and adulthood.

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